

CLAIMS

What is claimed is:

1. 1. A method of seismic data processing to correct for variable water velocities, the
2. method comprising:
 3. (a) determining an observed velocity;
 4. (b) determining a vertical time correction using said observed velocity; and
 5. (c) applying said vertical time correction to seismic data before normal
6. moveout.
1. 2. The method of claim 1 wherein determining an observed velocity further
2. comprises determining V_{obs} from $V_{obs} = V_w (\Delta t / T_{obs} + 1)$
1. 3. The method of claim 1 wherein determining an observed velocity further
2. comprises determining V_{obs} from velocity analysis of a seismic gather.
1. 4. The method of claim 1 wherein determining said vertical time correction further
2. comprises determining a time-dependent and offset-dependent correction for at
3. least one sample of the seismic data.
1. 5. The method of claim 1 wherein said vertical time correction is of the form
2.
$$\Delta t(\theta) = T_{obs} (V_{obs} / V_w - 1) / \left\{ 1 - \left[HV_{obs} / (T_{refl}(H) V_{rms}^2) \right]^2 \right\}^{1/2}$$
 where V_w is a selected
3. ideal velocity.

1 6. A method for determining a water velocity correction for seismic data, the method
2 comprising:
3 (a) determining a zero-offset static correction, Δt , for the seismic data that is
4 the difference between an observed time to a water bottom and an ideal
5 time to a water bottom determined using a selected ideal velocity;
6 (b) selecting an ideal water velocity, V_w , for the seismic data;
7 (c) determining a zero-offset water bottom time for the seismic data;
8 (d) determining an observed velocity, V_{obs} , for the seismic data; and
9 (e) determining a water velocity dynamic correction.

1 7. The method of claim 6 wherein determining said water velocity time correction
2 further comprises determining a time-dependent and offset-dependent correction
3 for at least one sample of the seismic data.

1 8. The method of claim 6 wherein said water velocity dynamic correction is of the
2 form $\Delta t(\theta) = T_{obs} (V_{obs} / V_w - 1) / \left\{ 1 - \left[H V_{obs} / (T_{refl}(H) V_{rms}^2) \right] \right\}^{1/2}$.

1 9. The method of claim 6 wherein said water velocity dynamic correction is
2 determined for at least one source-receiver offset.

1 10. The method of claim 6 wherein deriving said water velocity dynamic correction
2 further comprises determining at least one angle of seismic data raypaths for at
3 least one source-receiver offset.

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1 11. The method of claim 6 wherein determining an angle of seismic raypaths through
2 the water uses velocities from at least one of the list consisting of: i) normal
3 moveout velocities V_{rms} , ii) observed velocities V_{obs} , and iii) ideal velocities V_w .

1 12. The method of claim 6 wherein determining said water velocity dynamic
2 correction further comprises determining at least one seismic raypath through the
3 water using velocities from at least one of the list consisting of: i) normal
4 moveout velocities V_{rms} , ii) observed velocities V_{obs} , and iii) ideal velocities V_w .

1 13. The method of claim 12 wherein deriving said seismic raypaths further comprises
2 determining raypaths between a water surface and a water bottom, said water
3 bottom defined by using at least one of the group consisting of i) T_w , ii) T_{obs} and
4 iii) an arbitrary water bottom model.

1 14. The method of claim 6 wherein deriving said water velocity dynamic correction
2 further comprises determining V_{obs} from $V_{obs} = V_w(\Delta t/T_{obs} + 1)$

1 15. The method of claim 6 wherein deriving said water velocity dynamic correction
2 further comprises determining V_{obs} from velocity analysis of a seismic gather.

1 16. A method of seismic data processing, the method comprising:
2 (a) determining a zero-offset static correction, Δt , for the seismic data that is
3 the difference between an observed time to a water bottom and an ideal
4 time to a water bottom determined using a selected ideal velocity;
5 (b) selecting an ideal water velocity, V_w , for the seismic data;
6 (c) determining a zero-offset water bottom time for the seismic data;

7 (d) determining an observed velocity, V_{obs} , for the seismic data;

8 (e) determining a water velocity dynamic correction; and

9 (f) applying said water velocity dynamic correction to seismic data.

1 17. The method of claim 16 wherein said water velocity dynamic correction is
2 substantially of the form $\Delta t(\theta) = T_{obs} (V_{obs}/V_w - 1) / \left\{ 1 - [HV_{obs}/(T_{refl}(H)V_{rms}^2)] \right\}^{1/2}$.

1 18. The method of claim 16 wherein determining an observed velocity, V_{obs} , is of the
2 form $V_{obs} = V_w (\Delta t/T_{obs} + 1)$

1 19. The method of claim 16 wherein said water velocity dynamic correction is
2 determined for at least one source-receiver offset.

1 20. The method of claim 16 wherein determining said water velocity dynamic
2 correction further comprises determining at least one seismic raypath through the
3 water using velocities from at least one of the list consisting of: i) normal
4 moveout velocities V_{rms} , ii) observed velocities V_{obs} , and iii) ideal velocities V_w .

1 21. The method of claim 20 wherein deriving said seismic raypaths further comprises
2 determining raypaths between seismic receivers and a water bottom defined by at
3 least one of the group consisting of i) T_w , ii) T_{obs} and iii) an arbitrary water
4 bottom model.

1 22. The method of claim 16 wherein deriving said water velocity dynamic correction
2 further comprises determining V_{obs} from $V_{obs} = V_w (\Delta t/T_{obs} + 1)$

1 23. The method of claim 16 wherein deriving said water velocity dynamic correction
2 further comprises determining V_{obs} from velocity analysis of a seismic gather.

1 24. A method of seismic data processing to correct for variable water velocities, the
2 method comprising:
3 (a) determining an observed velocity;
4 (b) determining an angle dependent time correction using said observed
5 velocity; and
6 (c) applying said angle dependent time correction to seismic data before
7 normal moveout.

1 25. The method of claim 24 wherein determining said observed velocity further
2 comprises determining V_{obs} from $V_{obs} = V_w (\Delta t / T_{obs} + 1)$

1 26. The method of claim 24 wherein determining said observed velocity further
2 comprises determining V_{obs} from velocity analysis of a seismic gather.

1 27. The method of claim 24 wherein determining said angle dependent time
2 correction further comprises determining a time-dependent and offset-dependent
3 correction for at least one sample of the seismic data.

1 28. The method of claim 24 wherein said vertical time correction Δt , is of the form
2
$$\Delta t(\theta) = T_{obs} (V_{obs} / V_w - 1) / \left\{ - \left[H V_{obs} / (T_{refl}(H) V_{rms}^2) \right]^2 \right\}^{1/2}$$
 where V_w is a selected
3 ideal velocity.